The sterilisation of spices, herbs and vegetable seasonings:

Understanding the options

Sterigenics®

The spice of life

Spices, herbs, seeds and dehydrated vegetable substances bring a world of flavours, aromas and colours to food.

Harvested in the rural reaches of places such as India, China and Indonesia, spices and herbs develop their flavors and fragrances by fermenting in the sun, drying in the open air, and through processing techniques such as roasting and grinding. Once the appropriate flavours and aromas have been attained, the flavouring agents are shipped to brokers around the world using methods of transportation ranging from open barges to refrigerated trucks.

Unfortunately, during their long journey to the table, spices and herbs become contaminated with bacteria and molds. Bacterial contamination may come from soil, insects, bird or rodent droppings or from the water used in processing. Fungal growth may occur before or during drying, or during storage or shipping.

In any event, the consequences can be significant.

The risk of contamination

Bacterial contamination

Bacteria such as *Bacillus cereus* and *Clostridium perfringens* can cause a variety of foodborne illnesses. Fortunately, most foodborne pathogens cannot survive modern sanitation measures. Even in case of extreme contamination, bacteria that remain after processing are unlikely to tolerate further cooking or heating.

Salmonella has occasionally been found in spices (such as pepper) and herbal teas. Though normally destroyed by thorough cooking, the *Salmonella* in spices can cause illness when the spices are added to food toward the end of the cooking process, when foods are improperly refrigerated or when leftovers are improperly stored for several days.

Molds and fungal growths

Left untreated, mold can produce aflatoxins, which destroy the flavour and colour of the ingredients and make them unsuitable for use.

The additional threat of pests

Pests such as beetles and lesser grain borers are also commonly found in spices, seeds, herbs and prepared seasonings. Fortunately, since infectious pests are more susceptible to decontamination measures than bacteria or molds, technology used to control microbial contamination will also kill pests.

Two effective solutions

The world leader in microbial reduction services, Sterigenics offers the spice and food processing industries a choice of two sanitation options: ethylene oxide (EO) fumigation and irradiation processing.

While both effectively kill organisms, the challenges presented by the bulk packaging of spices and herbs have made ethylene oxide fumigation and gamma processing the methodologies of choice due to their efficient, high-density penetration.

Often, the final destination of the spice and herb product plays a dominant role in the technology selection. Although EO fumigation is widely utilised in the US, it is not currently accepted in the European Union.

EO fumigation: the original standard of excellence

A trusted means of spice sterilisation for more than 60 years, ethylene oxide fumigation uses alkylation as its mechanism of action.

Usage of EO for food sanitation accelerated dramatically in the 1960s with the discovery that EO fumigation could significantly reduce spoilage organisms in spices and spice blends. From that point until the approval of gamma radiation in 1988, EO was the tool of choice for herb and spice decontamination in the US.

In 2001, the US Food and Drug Administration (FDA) approved EO as a reconditioning technology for detained raw spices. Today, EO is also approved for spice blends, but only those that do not include salt (10CFR §185).

In order to ensure an effective result, the EO gas must be able to diffuse freely throughout the product being treated, making breathable packaging a necessity. In addition, because a non-volatile residue remains after processing, an aeration period is required to allow the residue to dissipate. Typically, the aeration process is complete within 24 hours.

Since ethylene oxide processing does not require labeling in the US, it remains a favoured sanitation agent for a significant number of the country's food processors.

Irradiation: today's most effective and most preferred choice

Irradiation is achieved either by gamma rays, pure energy rays emitted from Cobalt-60 and similar in many ways to microwaves, or by accelerated electrons, commonly known as electron beam (E-beam) irradiation. Approved by the FDA in 1988, gamma processing is the preferred method of food sterilisation in the US and on a global basis.

Less harsh and intrusive than EO, irradiation uses ionising energy to kill bacteria, mold and insects while retaining the flavours, colours, aromas and antioxidant properties of the flavouring ingredients.

While it is true that gamma processing can affect the sensory characteristics of some flavouring agents, the extent of the effect and the dose level required to cause a perceptible change varies by product. Ingredients that have been stored for a long time or those whose quality, flavour or aroma are not up to usual standards may be more affected than better quality spices.

A penetrating sterilant, gamma irradiation leaves no area of the product or packaging untreated. Even high-density products such as 250-liter fiber drums can be readily processed without the need for breathable packaging. Furthermore, gamma rays create no residues, so aeration is not required.

Likely effects of irradiation processing at various dose levels

Test Dose (in kGy)	Ingredients Tested	Results
4-10	Black pepper, white pepper, turmeric, rosemary, basil	Coliforms eliminated
5	Coriander, cumin, turmeric, chili, rosemary, basil	Starting fungal counts of 10^2-10^6 eliminated; coliforms eliminated
	Garlic powder	Coliforms not detected
	White pepper	3.0 log reduction total plate count
	Nutmeg	4.0 log reduction total plate count
	Ginger	2.0 reduction total plate count
6.5	Paprika, crushed red pepper	Standard plate counts<$3x10^3$; molds and coliforms eliminated
7	Cinnamon, cloves, coriander, nutmeg, white pepper, black pepper	2.5 to 4.0 log reduction total plate count
	Garlic powder	Starting from $5x10^4$ total plate count=below detectable level
7.5-10	Pepper, cardamom, mace, cinnamon, marjoram, cloves, caraway, coriander, charlock, juniper, paprika, black pepper, pimento, commercial spice blends	Virtual sterility
10	Cinnamon, cloves, coriander, nutmeg, white pepper, black pepper	1.7 log CFU/g
	Chili	Total plate counts below detectable level
	Herbs, garlic powder, onion powder	Standard plate counts<$3x10^3$; molds and coliforms negligible
	Black pepper, white pepper, turmeric, rosemary, basil	Spore forming bacteria<10^3
	Paprika, caraway seeds	Standard plate counts<$3x10^3$
12-15	Black pepper, white pepper, turmeric, rosemary, basil	Total aerobic bacteria reduced to below detectable level

The table above summarizes the work of several researchers and provides a general indication of the likely microbiological effects of processing at various dose levels for a range of spices grown in various countries. The actual dose used depends on factors such as the format of product, initial contamination level, type of microorganisms involved and packaging configuration.

Data compiled from *Irradiation of Dry Ingredients*, Farkas, 1988.

Irradiation in combination with other food processing

Since spices are used in foods that undergo other processes, it is important to know how irradiation works in combination with these other treatments. As a rule, irradiation improves the ability of subsequent processes to further lower microbial contamination.

- Microbial contamination levels in irradiated spices continue to decline during storage because radiation-damaged microorganisms cannot reproduce. This has been found to be true even when storage occurs at elevated temperatures and relative high humidity for several months.
- Microorganisms that survive irradiation are much more sensitive to heat. As a result, food groups that are heated and held at constant temperatures (such as soups from mixes used in food service operations) can have a longer storage life.
- Surviving microflora have been found to be less resistant to sodium and more sensitive to pH changes, moisture and growth temperatures. These sensitivities further reduce their ability to survive and grow in processed food products.

A look at labeling

Federal labeling requirements may be a key factor for some US manufacturers when making decisions regarding irradiation methodology (21 CFR § 179.26). While labeling is not required for food products containing EO-processed ingredients, products that have been decontaminated using gamma processing must prominently display the international symbol signifying irradiation—known as the "Radura"—and a statement that the products have been processed with irradiation. In the EU, every irradiated product must be labeled as "ionised."

Not surprisingly, labeling requirements vary from country to country:

- In the U.S., wholesale or bulk package labels, invoices or bills of lading must include a statement along the lines of "treated with radiation—do not irradiate again" if the product is shipped to a food manufacturer or processor for further processing, labeling or packaging.
- Irradiated spice and herb products that are merely cleaned, chopped, graded and/or repackaged must retain the irradiation label. However, an irradiated product that is roasted, heat treated or blended with other irradiated or non-irradiated spices or ingredients does not have to be labeled as irradiated.
- Labeling requirements vary from country to country.

Worldwide, the Radura symbol is the consumer's assurance of food safety. Research has confirmed that, when provided with factual information about food irradiation, consumers will choose irradiated products with confidence.

Ensuring the highest quality and safety

No matter which sanitation technology is selected, in order to prevent the contamination of finished food products it is important for dry ingredients to enter the processing area with very low bacterial and fungal counts. In most cases, only sterilised spices can meet the low plate counts specified by food processors manufacturing under HACCP[1] or ISO[2] standards.

Whenever products present a greater than average risk of foodborne illness or economic loss from spoilage, processors should use spices with the lowest possible microbial contamination. Such at risk products include:

- ready-to-eat foods that are minimally processed and do not require further cooking
- refrigerated foods sold at the retail level and those
- refrigerated foods used in food service operations
- snack foods, deli meats and cheeses, cooked poultry, meat products, salad dressings and refrigerated salads sold at retail.

[1] **Hazardous Analysis of Critical Control Points (HACCP):** Irradiation and HACCP are complementary weapons in the battle to ensure the safety of our food supply. HACCP is a plan that identifies the hazards associated with each food item and determines how each hazard can be reduced or eliminated. The microbial contamination of spices, herbs, and seasonings is a critical control point in many food-processing operations.

[2] **International Organization for Standardization (ISO):** A network of national standards institutes from 146 countries.

Sterigenics International, the sterilisation expert

The world's leading supplier of microbial reduction services for food products and food packaging, Sterigenics offers more technologies and more locations than any other provider.

With 40 processing centres across North America, Europe and Asia, and the widest range of technology choices, you can be sure Sterigenics is able to provide technology for every product and every processing requirement.

To learn more about how Sterigenics' expertise and technology can help your company extend product shelf life and prevent foodborne illness, call 800.472.4508 or visit www.sterigenics.com.

Related applications

- **Botanicals and health supplements**
  Many suppliers of botanical ingredients and manufacturers of natural health products rely on irradiation to ensure the cleanliness of their products—with little or no effect on active ingredients. As reported in 1998, tests of irradiation effects on active components of 36 traditional Chinese medicines showed less than a 3% loss of active ingredients at doses up to 10.0 kGy.

- **Pet feeds and chews**
  When the feed is destined for domestic pets, resident bacteria could affect the health of the pet's human family. Additionally, there have been multiple cases of children contracting *Salmonellosis* from handling dog chew treats such as pigs' ears, bullwinkles, rawhide and similar items. Irradiation has been shown to effectively eliminate these microorganisms.

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